



# Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

May 9, 2003

## Fire Fighter Dies During Night at Fire Station - North Carolina

### SUMMARY

On January 31, 2002, a 48-year-old male career Master Fire Fighter (the victim) was on duty at his fire station watching television at approximately 0100 hours when he last spoke with crew members. At approximately 0720 hours, crew members found the victim sitting in the same chair, apparently asleep. When they tried to wake him, they found him unresponsive, with no pulse, no respirations, and cool to the touch. Since he was obviously expired for some time, cardiopulmonary resuscitation (CPR) was not begun. He was transported by ambulance to the hospital where he was pronounced dead. The death certificate, completed by the Medical Examiner, and the autopsy, completed by the Chief Medical Examiner, both listed "ischemic heart disease" as the cause of death.

The following recommendations address some general health and safety issues. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- *Conduct mandatory preplacement medical evaluations consistent with NFPA 1582 to determine a candidate's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*

- *Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582 and the results of the exam are discussed with the fire fighter.*
- *Designate a City employee to administer the preplacement and annual medical evaluations and their outcomes.*
- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*

Although unrelated to this fatality, the Fire Department should consider this additional recommendation based on safety considerations:

- *Provide adequate fire fighter staffing to ensure safe operating conditions.*

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at [www.cdc.gov/niosh/firehome.html](http://www.cdc.gov/niosh/firehome.html) or call toll free 1-800-35-NIOSH

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### INTRODUCTION & METHODS

On January 31, 2002, a 48-year-old male fire fighter lost consciousness during the night while on duty at his fire station. The victim was transported to the hospital where he was pronounced dead. On March 26, 2002, NIOSH contacted the affected Fire Department to initiate the investigation. On August 12, 2002, a Safety and Occupational Health Specialist, an Occupational Nurse Practitioner, an Occupational and Internal Medicine Physician, and a visiting scientist from the NIOSH Fire Fighter Fatality Investigation Team traveled to North Carolina to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the

- Fire Chief,
- Safety Officer
- Crew members
- Victim's spouse

During the site visit NIOSH personnel reviewed the following:

- Fire Department policies and operating guidelines
- Fire Department training records
- Emergency medical service (ambulance) incident report
- Hospital emergency department report
- Death certificate
- Autopsy record
- Past medical records of the deceased

### INVESTIGATIVE RESULTS

**Incident.** On January 30, 2002, the victim arrived at his fire station for duty at 0800 hours. He was assigned to Engine 1 and spent the morning performing equipment checks and station maintenance. He was also assigned to inspect the battalion vehicle and to remove the SCBAs and positive pressure fan from the vehicle and to place

them in their appropriate locations. At approximately 1000 hours, Engine 1 (four fire fighters, including the victim) was assigned to flow hydrants in a particular area of the city. They flowed eight hydrants and returned to their station for lunch at approximately 1130 hours.

At 1213 hours, Engine 1 was dispatched to a mattress on fire alongside a roadway; however, the call was cancelled because it was outside the city limits. At approximately 1330 hours, Engine 1 and Engine 2 were assigned to the training ground to perform pump operator training. The victim assisted with laying out and rolling up hose. The training lasted approximately 3 hours, and back at the station, the victim cleaned the hose and equipment used during the training.

At 1846 hours, Engine 1 and Engine 3 were dispatched to a report of smoke in a structure. Upon arrival at 1849, the victim and another fire fighter were advised to don an SCBA and enter the structure (mobile home) to search for the origin of the smoke. However, as soon as the victim donned his SCBA, he was notified that his entry was not needed. The source of smoke was a pot that had been left on the stove, and no rescue or fire fighting was to be done. Crew members performed positive pressure ventilation to clear the residence of smoke, and units left the scene at 1922 hours.

At approximately 2200 hours, the victim reported having some indigestion to his wife, and he asked her to bring some antacids to the fire station. He took the antacids, and after a short visit, she returned home. The only other emergency response that evening was a medical first responder call (assist EMS 6) at 2243 hours. The victim assisted in patient treatment and loading the patient into the ambulance, and Engine 1 returned to the station. After Truck 8 returned to the station from two additional calls, the victim requested oral glucose from an EMT to restock the supply on Engine 1.

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After restocking Engine 1, the victim watched television in the station lounge. He was last seen alive by a crew member at 0100 hours, at which time he was comfortably watching television.

At approximately 0600 hours, a crew member arose from bed, and upon walking past the lounge, noticed the victim still sitting in the same chair. After performing a few chores, he and another crew member then went to the lounge (at approximately 0720 hours) to awaken the victim. He did not respond. Upon checking the victim, he was found to be unresponsive, not breathing, pulseless, and cool to the touch. An automated external defibrillator (AED) and the medical jump kit were retrieved, but upon further discussions, they realized that the victim had expired some time ago and that resuscitation efforts would be futile. The crew members notified the station officer, who notified dispatch at 0725 hours and requested an ambulance and a police officer. EMS Unit 2 arrived on the scene at 0729 hours and transported the victim to the hospital emergency department, arriving at 0752 hours. Again, no attempt at resuscitation was made. The victim was pronounced dead by the attending physician at 0750 hours.

***Medical Findings.*** The death certificate was completed by the Chief Medical Examiner, who listed ischemic heart disease as the immediate cause of death. No carboxyhemoglobin level was drawn. His alcohol blood screen was negative. Pertinent findings from the autopsy, performed by the pathologist, on January 31, 2002, included

1. Severe three vessel atherosclerotic disease:
  - Left circumflex is small but with a proximal lesion blocking 90% of the lumen.
  - The left anterior descending (LAD) has diffuse narrowing ranging from 90 to 99%.
  - The right coronary artery (RCA) has a long proximal lesion obstructing 75 to 99% followed by total occlusion.

2. Microscopic examination of one section of the heart reveals multiple small areas of fibrosis. But there is otherwise no evidence of acute or old infarction.
3. A normal sized heart (360 grams).

The Fire Fighter had the following risk factors for coronary artery disease (CAD): male gender, family history, tobacco use, hypercholesterolemia, and lack of strenuous exercise. The victim was currently prescribed an anti-inflammatory for musculo-skeletal pain but no other pertinent medications. Except for home and yard work, the fire fighter did not engage in any strenuous physical activity. According to his wife, family members, and coworkers, the Fire Fighter did not express symptoms of chest pain, shortness of breath, or any other symptom indicative of a heart condition at any time preceding the incident. The victim had an extensive history of indigestion.

On August 8, 2001, the victim had an annual fire fighter physical examination performed by his primary care physician. The exam revealed hypercholesterolemia and an abnormal resting EKG. Although he was referred for a stress test, he was cleared for fire-fighting duties. It is unclear if the deceased fire fighter followed up on this referral. The victim had undergone several stress tests over the past 10 years that were both abnormal and normal. The most recent exercise stress test (1996) showed no EKG changes indicative of ischemia. The patient was exercised by the Bruce protocol for a total of 8 minutes 27 seconds. The exertion level of 12.9 metabolic equivalents (METs) and a heart rate of 159 beats per minute (85% of maximum heart rate was 155) were achieved. His blood pressure response was adequate. His exercise tolerance was good.

**DESCRIPTION OF THE FIRE  
DEPARTMENT**

At the time of the NIOSH investigation, the combination Fire Department consisted of 52 career

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fire fighters and one volunteer serving a resident population of 22,000 in a geographic area of 12 square miles. There are four fire stations. Fire fighters, including the victim, worked the following schedule: 24 hours on duty, 48 hours off duty, from 0800 hours to 0800 hours.

In 2001, the Fire Department responded to 3857 calls: 2960 EMS calls, 275 service calls, 241 false alarms, 118 hazardous materials calls, 72 brush fires, 68 structure fires, 64 vehicle fires, 22 calls cancelled en route, 19 bomb threats, 14 trash fires, and 4 contracted services calls.

**Training.** New career fire fighter applicants must complete a physical agility test, an oral interview, and a physical examination before being hired. Once hired, the fire fighter receives training to become certified as a Fire Fighter I and II and an EMT-I. Fire fighters receive recurrent training in their station on each shift.

The State minimum standard for fire fighter certification is a voluntary Fire Fighter I and II program. The State requires 150 hours of training within a 5-year period for fire fighter recertification. Annual recertification is required for EMT and hazardous-materials certification. The victim was trained as a Master Fire Fighter, Hazardous Materials operations level, EMT-D, and Fire Service Instructor, and he had 18 years of fire-fighting experience.

**Preplacement Evaluations.** The Fire Department requires a preplacement medical evaluation for all career or volunteer new hires. The components of this evaluation are listed below:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests: comprehensive metabolic panel
- complete blood count with differential (CBC)
- cholinesterase

- heavy metal screen
- liver profile
- Routine urinalysis
- Spirometry
- Resting electrocardiogram (ECG)
- Chest X-ray
- Audiogram
- Vision test

These evaluations will be performed by a medical clinic under contract with the city. Once this evaluation is complete, a decision regarding medical clearance for fire-fighting duties is made by the examining physician and forwarded to the City Human Resources Department.

**Periodic Evaluations.** Annual medical evaluations are required by this Fire Department and consist of

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests: comprehensive metabolic panel
- complete blood count with differential (CBC)
- liver profile
- Urine tests: urinalysis
- Spirometry
- Resting electrocardiogram (ECG)
- Audiogram
- Vision test

These evaluations are performed by a medical clinic under contract with the City. Once this evaluation is complete, a decision regarding medical clearance for fire-fighting duties will be made by the examining physician and forwarded to the City Human Resources Department. In addition, the contracted clinic will also conduct cardiovascular fitness testing consisting of a cycle ergometer test (CET) using a 12-lead EKG to ascertain the pulse rate. If EKG changes are noted during the cardiovascular fitness testing, follow-up with the primary care physician will be recommended before clearance will be given



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for fire suppression activities. Medical clearance for SCBA use is conducted yearly by the same clinic that will perform the periodic evaluations. If an employee has either an occupational/nonoccupational injury or illness involving time away from work, he/she must be cleared for return to work by his/her private physician.

The Fire Department will be implementing a voluntary wellness program which includes nutrition and wellness information along with individual fitness plans based on the results of the cycle ergometer test provided by the contractor beginning in October 2002. Time will be allotted during the workday for a fitness program, but participation will not be mandatory. All fire stations currently have both strength and aerobic equipment. The victim did not exercise frequently, either at home or work.

**DISCUSSION**

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>1</sup> Risk factors for its development include increasing age, male gender, heredity, tobacco smoke, high blood cholesterol, high blood pressure, physical inactivity, obesity and overweight, and diabetes.<sup>2</sup> Besides gender, the victim had four of these risk factors: family history, tobacco use, hypercholesterolemia, and lack of exercise. Sudden cardiac death is often the first overt manifestations of ischemic heart disease.<sup>3</sup> Although prior to his fatal event the victim did not have symptoms suggestive of CAD, he did have abnormal EKG changes during his physical evaluation of August 8, 2001. These changes were interpreted as ischemic and agree with the autopsy findings of "focal fibrosis of the left ventricle of the heart."

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years,

typically decades.<sup>4</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>5</sup> Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.<sup>6</sup> This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. No thrombus was present at autopsy; however, identified were a long proximal 90% lesion of the circumflex artery, a 90-99% lesion of the left anterior descending artery, and a 75-90% long proximal lesion of the right coronary artery followed by a total occlusion. Blood clots, or thrombus formation, in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.<sup>6</sup> Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.<sup>7,8</sup>

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.<sup>9</sup> Fire-fighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.<sup>10-12</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>13-17</sup> Before his death, the victim had participated in a demanding training exercise and responded to two additional calls. Pulling and handling fire hose involves vigorous to extreme exertion, requiring 6-8 metabolic equivalents (METs).<sup>14, 18-20</sup> Most home and yard maintenance tasks involve 6 METs or less.<sup>14,19</sup>

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To reduce the risk of sudden cardiac arrest and heart attacks among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*.<sup>21</sup> NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.<sup>21</sup> NFPA 1582 recommends a thorough examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year).

NFPA 1582 also recommends, not as a part of the requirements but for informational purposes only, fire fighters over the age of 35 with risk factors for CAD be screened for obstructive CAD by an Exercise Stress Test (EST).<sup>21</sup> In this case, the victim had an abnormal resting EKG, but did not receive an EST to screen for ischemic heart disease.

### RECOMMENDATIONS

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the NFPA or fire service labor/management groups.

***Recommendation #1: Conduct mandatory preplacement medical evaluations consistent with NFPA 1582 to determine a candidate's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***

Guidance regarding the content of medical evaluations and examinations for fire fighters can be found in *NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*<sup>21</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.<sup>22</sup> The Department is not legally required to follow any of these standards. Nonetheless, we recommend that the Fire Department be consistent with the above guidelines.

In addition to providing guidance on the content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire-fighting tasks. NFPA 1582 should be applied in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for fire department administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. *NFPA 1500, Standard on Fire Department Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.<sup>23</sup>

***Recommendation #2: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582 and the results of the exam are discussed with the fire fighter.***

Physicians providing input regarding medical clearance for fire-fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the consensus guidelines published by *NFPA 1582, Standard on Medical*

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*Requirements for Fire Fighters and Information for Fire Department Physicians.* To ensure physicians are aware of these guidelines, we recommend that the Fire Department provide the contract and private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department not automatically accept the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition but also of the employee's job duties. Frequently, private physicians are not familiar with an employee's job duties, or guidance documents, such as NFPA 1582. Also, we recommend that all return-to-work clearances be reviewed by the department contracted physician. Thus, the final decision regarding medical clearance for return to work lies with the department with input from many sources including the employee's private physician. Lastly, we recommend that the results of the examination be discussed with the fire fighter.

***Recommendation #3: Designate a City employee to administer the preplacement and annual medical evaluations and their outcomes.***

This employee should maintain the confidentiality of the medical records. If this employee is a member of the Fire Department and participating in the City's annual medical evaluation, a policy should prevent them from administering the program to themselves.

***Recommendation #4: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program* and NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, require a wellness program that provides health promotion activities for preventing health problems and enhancing overall

well-being.<sup>23,24</sup> In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive *Fire Service Joint Labor Management Wellness/Fitness Initiative* to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.<sup>22</sup> The Fire Department should review these materials to identify applicable elements.

***Recommendation #5: Provide adequate fire fighter staffing to ensure safe operating conditions.***

This finding did not contribute to this fatality, but it was identified during the NIOSH investigation. Currently, the Fire Department staffs its engines with three personnel and its ladders with one person. NFPA 1710 requires that "on-duty personnel be assigned to fire suppression shall be organized into company units and shall have appropriate apparatus and equipment assigned to such companies."<sup>25</sup> Those companies may respond with two apparatus, depending on the seating configuration of the apparatus to ensure four personnel arrive on scene.<sup>25</sup> Personnel assigned to the initial arriving company shall have the capability to implement an initial rapid intervention crew (IRIC),<sup>25</sup> which requires four personnel (two to enter the structure and two standing by outside). NFPA 1500 recommends that "members operating in hazardous areas at emergency incidents shall operate in teams of two or more."<sup>23</sup>

Understaffing causes those members on the scene to work harder and for longer periods of time. Additionally, it requires the use of extra fire companies to meet the demand for manpower. Engine and Ladder Companies should be staffed with four personnel at a minimum.

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